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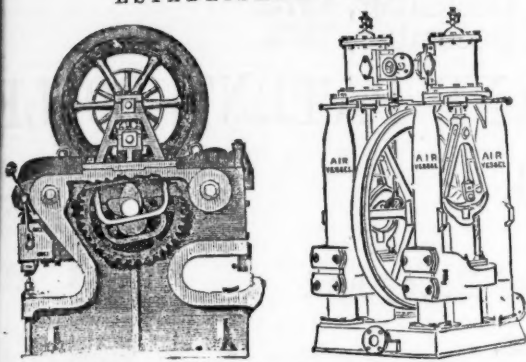
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No. 2066.—VOL. XLV.

LONDON, SATURDAY, MARCH 27, 1875.

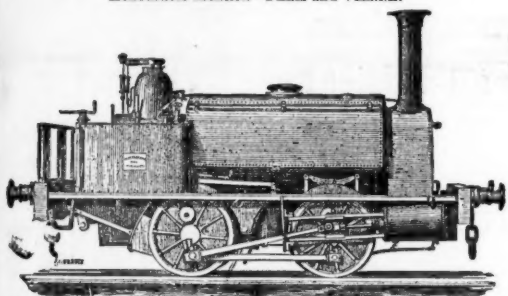
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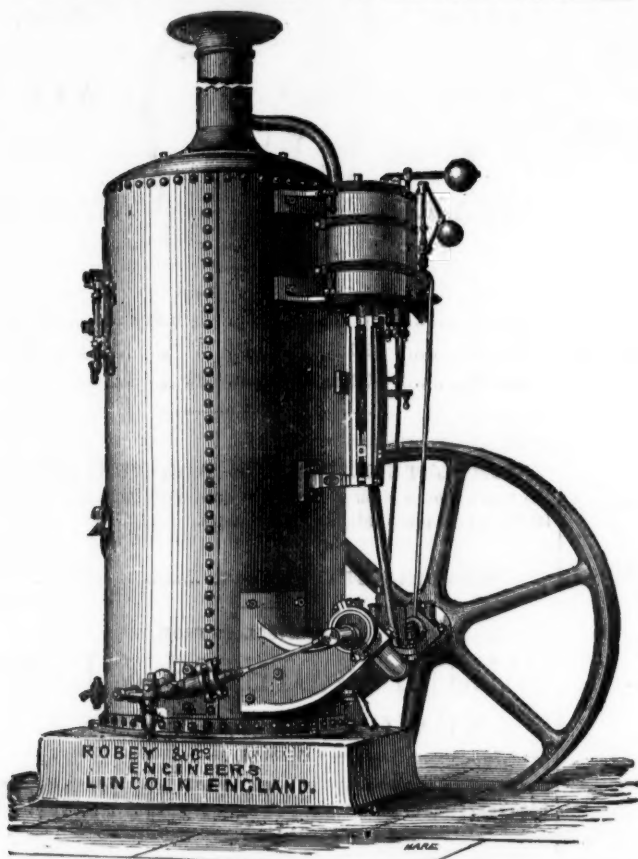
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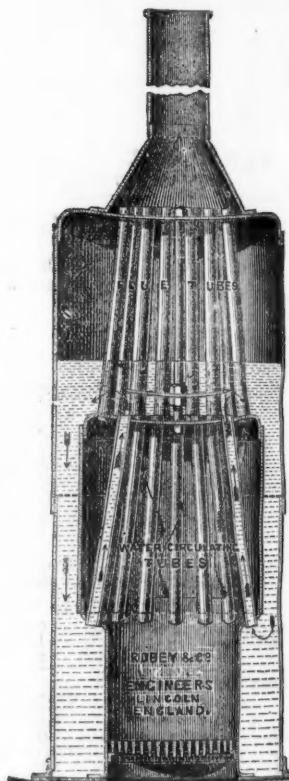
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All the districts on other localities in the furnace in the shire and Cleveland; requisite fuel for mining; Cumberland, and to a large extent, Ireland; while the sources of fossiliferous materials exist in the north, extending to the south being the coal fields throughout its "Magnesian Limestone" centre of this country be apparent when coal measures, thickness of up to the establishment of the vertical section. Independent numerous bands of coal reference to show the many shires as an iron and again in Lincolnshire and exhibits in the beds or measures to the establishment of the vertical section. The more important the Black Bed, the White Bed, and the Low beds of ironstone, known as the especially iron percentage of the coal by Mr. Wood, Carbon, Hydrogen, Sulphur, Ash, Oxygen and This coal is exposed in the reduction of the iron. When coked in the large Beneath the "fire-clay," various layers of the Southwards mineral field upwards of 300 feet thick coal, with the bottom of the above-named and also the f The Swallow balls, and bottom gate Mine, with the Tankersley yielding 4000 Parkgate, with each giving 1 stone coal is as the Clay W The great iron of ironstone when the late of the kingdom ores produced two-thirds. Those of North shire, Yorkshire, Durham, and the district vary by the following the "Iron Ore Spiller." We get of iron, carb

White Bed M
Black Bed M
Thorncliffe O
Thorncliffe W
Black or Clay

The average of tallic iron, exposed to the air and their remains they lose from consisting of carbon previously stored of iron furnaces United Kingdom. Pig-iron closely identical the smelting scale at a reduction from the year of Bowling, intensive work were at first ever, till the of Sandall, iron ore contains facts showing from a paper read at The Bowling 360 tons of pig-iron welded and two pig-iron blowing cylinders engines of machines, steel, having the principle of Siemens' regenerative gas works and Wilcock's

THE IRON INDUSTRIES OF THE WEST RIDING
OF YORKSHIRE.

By RICHARD MEADE, Assistant Keeper of Mining Records,
Museum of Practical Geology.

All the districts previously considered are more or less dependent on other localities for some of the materials employed in the blast-furnace in the manufacture of the crude metal. Thus Northamptonshire and Cleveland, or the North Riding of Yorkshire, import the requisite fuel for all the operations of smelting, puddling, and refining; Cumberland and Lancashire draw supplies of coke from Durham, and to a limited extent iron ores from foreign countries and Ireland; while Durham and Northumberland, though rich in resources of fossil fuel, are almost entirely supplied with iron ores from other parts of Great Britain and European states to feed their blast-furnaces. In the West Riding of Yorkshire, in which occurs the northern part of the Great Midland coal field, all the essential materials exist in abundance—coal, ironstone, and limestone to furnish a flux in the operation of smelting. The Great Midland coal field, extending through the shires of York, Derby, and Nottingham, has a known area of about 800 square miles, its length from north to south being upwards of 60 miles. It is the most continuous of the coal fields of Great Britain, and is almost entirely exposed throughout its area, its eastern margin only being covered by the "Magnesian Limestone" or Permian rock. Sheffield occupies the centre of this great field, the extent and importance of which will be apparent when it is known that it possesses in section 4300 ft. of coal measures, in which occur 15 seams of coal, each seam having a thickness of upwards of 2 ft., and yielding 46 ft. of vertical coal, while of the numerous seams less than 2 ft. in thickness we have a vertical section equal to 53 ft. of coal.

Independent of the coal seams, and interstratified with them, are numerous bands or seams of ironstone, to which, immediately, especial reference will be made. The few foregoing facts will sufficiently show the many advantages possessed by the West Riding of Yorkshire as an iron-making district. In the neighbourhood of Bradford, and again in Leeds, the Yorkshire mineral field is well developed, and exhibits in an interesting manner the occurrence of those valuable beds or measures of ironstone and coal which have given rise to the establishments of Bowling, Low Moor, and Bierley, and more recently those of Farnley and Beeston Manor.

The more important of the ironstone measures in the districts of Bradford and Leeds are those known as the White Bed Mine, and the Black Bed Mine, or Low Moor bed, of ironstone, worked extensively between Low Moor and Leeds; there is, however, considerable irregularity in the thickness of these beds, and in the distribution of the nodules, and hence a variation in the yield of ironstone. The White Bed Mine, at Bierley, yields an average of 1200 tons per acre, the Low Moor bed is much more productive; beneath these beds of ironstone lies a seam of coal, not exceeding 2 feet, locally known as the "better bed," remarkably free from impurities, more especially iron pyrites, and consequently containing but a small percentage of sulphur. The "better bed" furnishes by analysis, made by Mr. Wood, of Leeds, the following constituents:—

Carbon	74.700
Hydrogen	5.000
Sulphur	1.196 very small
Ash	4.700
Oxygen and nitrogen	15.404 = 100.000

This coal is extensively coked, and is almost exclusively used in the reduction of the ores in the smelting operations of the blast furnace. When coked it yields 62 per cent., and from its density, hardness, and the large amount of carbon it contains, it forms a valuable fuel. Beneath the "better bed" of coal occurs a valuable seam of indurated fire-clay, varying from 2 ft. to 3 ft. in thickness. This fire-clay furnishes a superior quality of fire-brick, and is also much used as a lining in the blast-furnace.

Southwards, by Wakefield, Barnsley, Rotherham, and Sheffield, this mineral field is extremely rich in its ironstone and coal to a depth of upwards of 300 yards. In the top of the series occurs the Barnsley Thick coal, which varies in thickness from 6 ft. to 9 ft. 6 in., and at the bottom occurs the Silkstone seam of coal, 4 ft. thick; between the above-named seams of coal are several others of less thickness, and also the following ironstone measures, in descending order:—The Swallow Wood Mine, Milton, consisting of three bands, of flats, balls, and bottom measures, yielding 1500 tons per acre; the Lidgate Mine, with similar bands, yielding about 1800 tons per acre; the Tankersley Mine, with from 12 to 15 in. of ironstone measures, yielding 4000 tons per acre; the Thornccliffe, or Old Black Mine, Parkgate, with 11 in. of measures, and the Thornccliffe White Mine, each giving 1500 tons per acre. At the bottom, and before the Silkstone coal is reached, occurs another thin seam of ironstone, known as the Clay Wood, or Black Park Mine, Parkgate.

The great importance of the argillaceous and blackband deposits of ironstone will be understood from the fact that in the year 1851, when the late Mr. Samuel Blackwell made a report on the iron ores of the kingdom, the coal fields furnished nine-tenths of all the iron ores produced, while in 1873 the same sources of supply furnished two-thirds. The coal fields most abundantly supplied with these ores are those of North and South Wales, Staffordshire, Shropshire, Derbyshire, Yorkshire, and Scotland, while in the coal fields of Northumberland, Durham, and Lancashire they exist but to a very limited extent. The clay ironstone, or argillaceous carbonates of iron, of this district vary slightly in their composition, which will best be shown by the following statement, selected from analyses published in the "Iron Ores of Great Britain," Part I., chiefly made by Mr. John Spiller. We give the proportions in each specimen of the protoxide of iron, carbonic acid, and the metallic iron contained—

	Protoxide of iron.	Carbonic acid.	Metallic iron.
White Bed Mine, Bierley.....	35.38	25.41	28.76
Black Bed Mine, Low Moor.....	36.14	26.57	29.12
Thorncliffe Old Black Mine, Parkgate.....	41.77	31.39	34.16
Thorncliffe White Mine, Parkgate.....	39.38	29.38	31.83
Black or Clay Wood Mine, Parkgate.....	39.87	28.47	31.92

The average yield of these ores may be taken at 32 per cent. of metallic iron. These ores, before calcination takes place, are usually exposed to the air, when the adhering particles of shale disintegrate, and their removal is easily effected. In the operation of calcining they lose from one-third to one-fourth of their weight, the loss consisting of carbonic acid and water. It may here be mentioned, as previously stated, that at the present time the argillaceous carbonate of iron furnishes nearly two-thirds of the total annual produce of the United Kingdom.

PIG-IRON MANUFACTURE.—The early history of this industry is closely identified with that of Bradford. Although evidence exists of the smelting of the argillaceous ores of the coal measures on a limited scale at a remote period, yet it may be said in modern times to date from the year 1781, when the Bowling Company purchased the manor of Bowling, with its ancient hall, and laid the foundation of the extensive works now existing there. The operations of the company were at first confined to foundry and smiths' work. It was not, however, till the year 1788 that the furnaces erected by Mr. John Sturges, of Sandall, near Wakefield, were put in blast, and the smelting of iron ore commenced. And here it will be interesting to note a few facts showing the magnitude of the works as they stand in our day, from a paper by Mr. Joseph Wilcock, chief engineer to the company, and read at the Bradford meeting of the British Association in 1873. The Bowling Works comprise six cold-blast furnaces, from which 600 tons of pig-iron are run per week, five refineries, twenty-one puddling-furnaces, an extensive forge, a tyre mill for rolling steel and iron weldless tyres, one guide mill, one bar mill, with 15-in. rolls and two plate mills. In the ironworks are three blast engines, with blowing cylinders, varying from 76 to 84 in. in diameter, and fourteen engines of from 20 to 60-horse power to give motion to the various machines. There are also extensive steelworks for making crucible steel, having about 100 pot furnaces, and other furnaces on the principle of Siemens, and Siemens-Martin, worked by Siemens' regenerative gas furnace. For further details concerning the Bowling Ironworks and Collieries, which possess much interest, a perusal of Mr. Wilcock's paper will be found most instructive. The Low Moor

Ironworks were established in the year 1790 by Mr. Joseph Dawson. The superior quality of the iron made here and at the Bowling Ironworks may be briefly stated as follows:—Great strength and tenacity, uniformity of texture, hardness, and great pliability, in addition to its being susceptible of a high polish, and withstanding the action of heat; these special qualities cause the iron to be in great request in the numerous industries abounding in Sheffield, where it is extensively used.

The Shelf Ironworks, near Halifax, commenced the make of pig-iron about 1795, and were subsequently acquired by the Low Moor Company; and in 1797 the Rotherham Works were established. The pages of the Royal Coal Commission Report, vol. iii., afford much valuable data bearing on the early history of the iron trade. In 1740 the production of six furnaces in this division of Yorkshire, in which coal was used, is stated at 1400 tons; another return from the same source gives the yield of the Bowling furnaces, between the years 1795 and 1798, at about 2000 tons per annum. The make of the Low Moor furnaces, about the same period, being in 1795, 2573 tons; and in 1798, 2658 tons; while the works at Shelf and Rotherham are stated to have made, about the same years, 3442 tons and 3000 tons respectively.

When, in 1796, Mr. Pitt proposed to levy a duty, or tax, on coals, payable at the pit's mouth, a formidable opposition was offered to the measure in Yorkshire, the ironmasters strongly resisting the proposed impost. A Committee of the House of Commons was appointed to enquire into the project, and the measure was abandoned, but resulted in a very interesting return being published, showing the make of pig-iron in Great Britain in that year, of which the following gives the details:—

Counties	Furnaces.	Tons	Pig-iron.
Cheshire	2	.....	4,710
Cumbland	4	.....	5,144
Derbyshire	3	.....	2,138
Gloucestershire	5	.....	2,850
Yorkshire	23	.....	580
Shropshire	23	.....	21,984
North and South Wales	28	.....	68,120
Staffordshire	28	.....	45,994
Sussex	14	.....	15,820
Scotland	1	.....	172
.....	17	.....	16,088
Total	121	.....Tons	183,407

It will be seen from the foregoing that the production of iron in Yorkshire amounted in the year 1796 to 21,984 tons, the make of 22 furnaces, or an average make per furnace of 1000 tons. From this period we advance to 1806, when the make of 27 furnaces, of which 23 were in blast, amounted to 26,671 tons, or an average of 1160 tons per furnace. Again, in 1839, the recorded make of 22 furnaces is given as 52,416 tons, or an average of 2382 tons; in 1847 the yield of 23 furnaces increased to 67,600 tons, or an average of 3073 tons per furnace. Advancing to the year 1851, the following presents a complete list of the works in operation in the Northern and Southern divisions of the district of the West Riding, cold-blast being principally employed in the furnaces:—

NORTHERN DIVISION.			SOUTHERN DIVISION.		
Works.	Furnaces. Built.	In blast.	Works.	Furnaces. Built.	In blast.
Bowling	5	3	Chapeltown	2	1
Bierley.....	4	3	Elsecar and Milton ..	3	0
Furnley.....	1	1	Holmes	2	1
Low Moor	3	3	Parkgate	1	4
New Begin	2	2	Thorncliffe	1	2
Shelf.....	1	0	Worsborough Dale ...	1	0
Total.....	13	10	Total.....	13	5

Thus, it will be seen at this time, of the 29 furnaces built 15 were in operation, the make of the Northern Division being 25,000 tons, and the Southern Division 40,000 tons, or an aggregate of 65,000 tons, giving an average yield per furnace of 4333 tons.

A few years later, in 1855, the Beeston Manor and Thorpe Hall Works commenced operations each with one furnace in blast; and in 1865 the York Road and Hepworth Works, the former with two and the latter with one furnace, while in 1868 the furnaces at Ardsley, near Leeds, of the West Yorkshire Iron and Coal Company were blown in, and more recently, in 1872, those of the Atlas Works. Having briefly stated the date of the establishing of the ironworks, it will be well to give a list with the owners and furnaces built and in blast in the year 1873, when the total quantity of pig-iron made in Great Britain amounted to 6,566,451 tons, of which the West Riding and the Cleveland districts contributed in the proportions of 24 per cent. and 17½ per cent. respectively.

Works.	Owners.	Furnaces.
		Built. In blast.
Atlas	Sheffield ... Sir John Brown and Co. (Limited)...	2 2
Beston Manor..	Ardley A. Harding and Co.	2 1
Bowling	Bradford ... Bowling Iron Company (Limited) ...	6 4
Elsecar	Barnsley ... W. H. and George Dawes	6 4
Milton		
Farley	Leeds Farnley Iron Company (Limited) ...	4 2
Holmes	Rotherham . Parkgate Iron Company (Limited)...	5 5
Parkgate		
Low Moor	Bradford ... Hird, Dawson, and Hardy	8 6
Bierley		
Thorncliffe ..	Sheffield ... Newton, Chambers, and Co.	3 2
West York	Leeds York Road Iron and Coal Company ..	2 2
York Yorkshire.	Ardley West Yorkshire Iron & Coal Co. (L.)	5 4

Total of West Riding. 49 39

The Atlas and York Road furnaces were in blast but a part of the year. To bring the history of the annual production of pig-iron up to date the following statement will show at a glance the progress of the industry in the years named, and side by side, for reference, the production of the North Riding, or Cleveland district, in the same years:—

Year.	WEST RIDING.		NORTH RIDING.	
	Furnaces. Built.	In blast.	Make of pig-iron. Tons.	Make of pig-iron. Tons.
1855	32	25	90,840	54,500
1857	36	25	117,000	179,838
1860	35	25	98,100	248,665
1863	35	24	104,745	316,197
1866	35	29	119,747	546,091
1869	38	23	105,765	706,410
1870	38	22	77,717	907,970
1871	38	22	77,717	1,022,885
1872	40	29	148,638	1,122,144
1873	42	34	151,511	1,166,431

Showing an increase in production in the West Riding in 18 years of 66 per cent, while in the Cleveland district the increase amounted since 1860 to 365 per cent., a progress unsurpassed by any other iron-producing district in Great Britain.

COAL AND ORE USED IN MAKING PIG-IRON.—In the make in 1873 of the 151,511 tons of pig-iron in the West Riding of Yorkshire there was used of coal, the equivalent of the coke which is principally employed in the district, 493,976 tons, equal to 65 cwt. of coal to each ton of pig-iron made; it will, however, be remembered that in those districts where cold-blast is employed the consumption of fuel is considerably greater than where the hot-blast is used. In the production of the above 151,511 tons of pig-iron, the quantity of ironstone of all kinds employed amounted to 499,000 tons, or an average of 66 cwt. of raw (uncalcined) stone to each ton of pig-iron made. This quantity was made up approximately as follows:—

	Quantities.
West Riding of Yorkshire.....	Tons 240,438
North Riding of Yorkshire.....	110,000
Northamptonshire.....	83,512
Lincolnshire.....	60,000
Other places.....	15,000
Total	499,000

MILLS AND FORGES.—The manufacture of bar and other forms of malleable iron has been long carried on in this division of Yorkshire; indeed, the old established forge at Kirkstall, a few miles west of Bradford, is generally regarded as the most ancient works of the kind in the kingdom, and they still prosper. In the years 1872 and 1873 there existed in the vicinity of Leeds and Bradford 12 of these important works, and in the districts of Sheffield and Rotherham 11 such works, having an aggregate of 579 puddling-furnaces and 116 rolling mills, of which the following is a complete list:—

Name of works.	Name of firm.	Situated.	Pdding. Rolling furnaces, mill.
Leeds and Bradford districts:—			
.....	Coghlan and Drury.....	Leeds	23 5
.....	Taylor Brothers and Co.....	Ditto	17 5
.....	Farnley Iron Co.....	Ditto	12 4
.....	T. J. O. and A. Butler.....	Ditto	24 3

Leeds	S. T. Cooper and Co.	Leeds	14	5
Monk Bridge	Monk Bridge Iron Co.	Doitto	27	1
Thornhill Löss	Doitto	Doitto	11	1
Perseverance	J. Whittham and Son	Doitto	11	1
Bowling	Bowling Iron Company	Bradford	30	7
Low Moor	Hird, Dawson, & Hardy	Doitto	40	7
Water Lane	L. Perkins and W. Terry	Doitto	7	2
Culder Vale	Samuel Whitlam	Wakefield	28	4
<i>Rotherham district.</i>				
Atlas Steel and Iron	John Brown & Co. (L.)	Sheffield	78	21
Cyclops	Chas. Cammell & Co. (L.)	Doitto	39	9
Gremisthorpe	Doitto	Doitto	—	1
Yorkshire Steel and Iron Works, Penistone	Doitto	Doitto	—	4
Wortley	Andrews and Co.	Doitto	6	3
Midland	Midland Iron Co. (L.)	Rotherham	29	3
Phoenix Steel and Iron	Owen's Patent, Tyre, and Ax Co., Compel.	Doitto	1	2
Parkgate	Parkgate Iron Company	Doitto	82	6
Northfield	Neill, Johnson, & Edgar	Doitto	33	3
Elsecar and Milton	W. H. and G. Dawes	Elsecar	68	7
Stockbridge	Samuel Fox and Co. (L.)	Sheffield	4	—

Total of West Riding	579	116
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Coincident with the development of our railway system, Sheffield more especially became the seat of many new branches of iron and steel manufactures, such as rails, tyres, axles, wheels, girders, railway wagons, and all forms of forgings and castings for fixed and rolling stock, armour plates, &c. The gigantic establishments, the Atlas and Cyclops, have exercised such an important influence in connection with the national defences of the empire that we may be excused referring generally to them. The first-named works commenced operations in the year 1857, under the auspices of Sir John Brown and Co., and initiated the manufacture of those vast plates of iron which have in modern times contributed to the armour covering of our ironclads, besides other heavy iron work. A few years later the Cyclops Steel and Iron Works was founded by Messrs. Charles Cammell and Co., and these two firms stand unrivalled in the resisting power their armour plates offer to the heaviest ordnance directed against them. The Messrs. Cammell and Co. have other works of an extensive scale at Gremisthorpe and Penistone, at the former of which the manufacture of cast steel is carried on, also the manufacture of steel by the Martin-Siemens process, while at Penistone steel is made by the Bessemer process.

BESSEMER STEELWORKS.—The manufacture of steel by this process, the invention of Mr. Henry Bessemer, is carried on extensively in the neighbourhood of Sheffield. The following is a list of those important establishments, with the names of the firms, and the number and capacity of the converters, as they stood in 1873:—

Works.	Firms.	Converters—No.	Capacity Tons
Bessemer ... Sheffield ...	Henry Bessemer and Co.	2	3
Atlas	ditto	2	5
Atlas	John Brown and Co. (Limited) ..	2	10
Cyclops	ditto	2	7
Phoenix	Charles Cammell and Co. (Limited) ..	2	6
Phoenix	Rotherham , Phoenix Iron Company ..	4	4
Stockbridge	Despach ..	2	3
Stockbridge	Samuel Fox and Co.	2	5
Yorkshire	ditto	2	6
Yorkshire	Charles Cammell and Co. (Limited) ..	2	7
Yorkshire	ditto	2	5

COAL CONSUMED IN MILLS, FORGES, ROLLING MILLS, AND STEEL WORKS.—The total quantity of coal employed in the above-named works amounted in the year 1873 to 979,700 tons, of which the works in the neighbourhood of Sheffield and Rotherham consumed 516,700 tons, while those of the districts around Leeds, Bradford, and Wakefield consumed 463,000 tons.

METAL EXTRACTION WORKS IN THE WEST RIDING OF YORKSHIRE.—This industry is represented by one establishment, that of Messrs. Morris and Company, situated at Doncaster. The "burnt ore" operated upon in 1873, by this firm, amounted to 7000 tons, and was obtained from the chemical manufacturer who had previously separated the sulphur from the copper pyrites. At these works the copper is separated from the "burnt ore" above referred to, and a residue is left, known as "purple ore." This residue is of considerable value, containing from 62 to 67 per cent. of metallic iron.

and is extensively used as a fettling material in the puddling furnaces of the district.

In conclusion, it may generally be observed that the iron-making resources of the West Riding are rapidly increasing. Towards the close of the past year new furnaces were put in blast at the Milton, Thorncliffe, and Atlas Works, and much importance attaches to the evidence of Sir John Brown, who in July last, before a Parliamentary Committee on the Wakefield Water Bill, stated that his company, the Atlas Works, were producing from 5000 to 6000 tons of iron weekly, and that a new industry was springing up around Sheffield—the smelting of iron ores, there being at that time 7 or 8 blast furnaces in the district, all of which had been built during the previous three years, and it was his impression that during the next two or three years 50 additional furnaces would be erected, and the iron ores of Spain brought into the district and smelted there.

EXPLOSIVES USED IN BLASTING.

SIR,—An explosive in comparison to its power of overcoming inert resistance is a desideratum, and one which every miner appreciates. Nature has given us great resistance in the cohesion of minute particles having an affinity for each other, and which from pressure, heat, or other causes, renders its disintegration difficult, if not often perplexing, to the miner. If Nature, then, has made some things tough, and to all appearance durable, as being hard to break, has she not in another form provided a power which will dissipate this apparently eternal substance, sending back to original elements to await again subjection to the laws which formerly gave it solidity and consequently resistance? This idea appears to have prevailed, and is now prevailing, in the mind of the chemist and the student of nature. An explosive is effective in proportion to the power and suddenness of complete combustion—the annihilation of anything like a compound existing—the more completely and the more perfectly this is effected in the least possible time the greater the effect. In order to direct attention to this subject, in the hope that someone may evolve out of it a thread that may lead us to a cheaper and more effective blasting power than is at present to be had at a reasonable price, is the desire of the writer.

I will here give a few extracts from the researches of M. Bertholet (a French chemist), on the force of certain explosives:—

	Heat.	Volume of gas.	Estimated excess of explosive force.
Blasting powder	609	0.173 litre...	88
Artillery powder	608	0.225 "	137
Powder, nitrate of soda for its base	764	0.248 "	190
Powder, chloride of potash for its base	673	0.265 "	309
Gunpowder	1420	0.407 "	87
Gunotton,	1420	0.484 "	87
Gunotton, with chloride of potash	1320	0.710 "	930
Nitroglucine			

M. Berthollet remarks on nitroglycerine "as being really the ideal of portable force." "It burns completely without residue—in fact, gives an excess of oxygen; it develops twice as much heat as powder, three-and-a-half times more gas, and has seven times the explosive force weight for weight, and taken volume for volume, it possesses twelve times more energy." "Theoretically there is but one substance that can surpass it—i.e., liquified protoxide of azote, mixed with ether or other liquified carburets; these mixtures range up to 1400° of heat, and their energy is expressed by the number 1000. But it is commercially impossible to obtain the instantaneous explosion of such mixtures formed with liquified gases, because it would be necessary to compress these gases into a liquid form, preserve them in vessels hermetically sealed, in which form they must be mixed and fired, otherwise only a force of about 10 to 20 atmospheres could be obtained."

It is a very important matter that the explosive employed should be powerful. If a weak fuse be employed in blasting a hole charged with dynamite or nitroglycerine the effect is diminished in proportion to the slowness of decomposition of the explosive. The decomposition of explosives developing their utmost energy is said to be in guncotton, as travelling nearly 20,000 ft. per second, and for nitroglycerine a still more rapid velocity. It is very doubtful whether this matter of velocity has until very recently been appreciated, nay, if ever thought, of by the practical miner. Velocity in become gases in the millionth part of a second, if such a division o

mining is everything. If the charge burns slowly no effect but the decomposition of itself results; if possible, the whole charge should time can be computed or imagined; perfect action simultaneously does the work.

Of late years dynamite has become much used in our western mines. This varies in effect according to the quantity and quality of the nitroglycerine, which constitutes its explosive character. It has hitherto been sold at an extravagant price, and that without any warranty of its quality or effect-producing capability. A blind and irrational way of doing business. A second quality is retailed at 1s. 4d. per lb. This is described as containing 20 per cent. of nitroglycerine, but is little, if any, stronger than the best powder. The best quality is sold at 2s. per lb. A similar quality is sold at 1s. 3d. per lb. in Germany. So much for the existence of patent laws rashly granted to a monopoly in its production.

Of the two explosives, dynamite and nitroglycerine, the relation of cause and effect is as 60 or less to 100. The result of practical workings in the Hoosac Tunnel was that the nitroglycerine would blast out holes four times the depth of powder-charged holes, and much deeper holes than dynamite, lithofracteur, dualin, or other mixture of nitroglycerine.

We must come back to the vital question, and ask—Can nitroglycerine be safely used in our mines? Can it be safely conveyed from the manufactory to the mine? Can it be safely stored? Can the men use it without ill effects? To all these questions I should unhesitatingly say yes—where intelligent caution is exercised the danger is not greater than with dynamite. Hundreds of tons of tri-nitroglycerine are made in America and transported hundreds of miles over the roughest roads without accident. It is being employed in mining operations there with as great an immunity from accident as dynamite is here. Why cannot our miners avail themselves of it as well as Cornishmen and Americans in America?

47, Threadneedle street, City, March 23. H. WADDINGTON.

ROCK DRILLS—YORKSHIRE VERSUS PRUSSIA.

SIR.—There is not the least need of a summer excursion to Prussia to open the eyes of the Cornish or Yorkshire miners; they will have opened them wide enough on reading Mr. H. Waddington's letter in the Journal of the 20th inst. in mute amazement that any man calling himself a miner could work a forehand in the manner described. With one machine I have cut 33 fms. during the last six months, at the average rate of 22 in. per diem. Mr. Waddington with four machines has averaged 11 2-10 in. per diem during one month. I have, therefore, doubled his distance with one-fourth of his power. The average cost of dynamite and fuse with me was 17. 0s. 14d. per fathom; with Mr. Waddington the cost of dynamite and fuse was 17. 1s. 8d. per metre. With me every fathom required 30 holes, averaging 72 ft., or 864 in.; with Mr. Waddington every metre required 21 holes, averaging 54 in. each, or 1134 in. Our average rate of progress being, as before stated, 22 in. per diem, or 888 in. monthly. To gain this advance we have had to bore 5184 in., that is to say less than six in. boring for every inch of advance:—

$$5184 \div 888 = 5.84 \text{ in. nearly.}$$

If you refer to Mr. Waddington's statement you will find that for every inch of advance he had to bore 29 in., that is to say, six times as much boring, thus:—

$$147 \text{ holes} \times 54 \text{ in.} = 7938 \text{ in.; and } 7 \text{ metres} = 273 \text{ in.; then, } 7938 \div 273 = 29.$$

Which is the best system of mining? No miner can look at the diagram of the level forehand, as given in your paper, without bursting into a roar of laughter. Any miner's lad of 12 years of age can see that half the holes are utterly useless. What must be the wear and tear of four machines uselessly hammering away and smashing themselves to bits, compared with the wear of one used by Yorkshire miners and doing double the work of four? Mr. Waddington had better treat his Prussians to a trip to the Yorkshire Dales, and have them taught how to put in their holes. GEO. WM. DENYS, March 24.

ROCK DRILLS.

SIR.—Will you kindly lay before your readers the following? At the Sutor Tunnel, in Sierra county, Nevada, the Burleigh drills have given great satisfaction, having made some wonderful progress, exceeding any tunnelling work ever before accomplished. A number of mines in California are now using the drills, and we give below a summary of the results accomplished by the Golden Star Company last month. The superintendent furnishes the report on the working of the machinery in the Golden Star Tunnel, near Alleghany, Sierra county, for the month ending Jan. 30 last, of 44 shifts work. The ground is a cement mixed with crystalline trap and granite boulders. The machinery used is one stoping drill and a No. 1 compressor:—

Size of tunnel	7 ft. by 7 ft.
Total holes drilled	258
Number of feet drilled (in 788 holes)	2653
Size of holes	1 1/2 in.
Actual distance of tunnel driven	111 feet.
Average depth of holes	3 ft. 6 in.
Average speed of drilling per hour	16 feet.
Average time occupied drilling per shift	3 hrs. 45 min.
Fuel consumed per 24 hours (green cedar)	3/4ths of a cord.
Steam pressure	65 lbs. per square inch.
Air pressure	65 lbs. per square inch.

All the time the boiler was standing in an open shed without steam-jacket or lagging. The lubricants consumed for the month were 3 gallons of oil, 10 lbs. of tallow, and 1 lb. of blacklead. The stoppage for repairs to the machinery for three months has been 15 minutes, at a cost of 50 cents.

The results obtained by the Burleigh drill, and the statistics published in last week's Journal by Mr. H. Waddington, I should think would convince the most sceptical, even your correspondent "Pedn-an-drea," who seems to have many prejudices towards the introduction of rock drills over hand labour in developing mining and other properties, and has shown by his letters he practically knows as much about the rock drill and its merits as a rock drill knows about him, and I agree with Sir G. W. Denys that he has not proved himself a thorough practical miner by his calculations, by having to drill 130 holes to cut 1 fm. of ground. I have been connected with mines for a number of years, in all kinds of ground, and in the hardest of rock I never found it requisite for my men to drill even half that number. In the past week I have made the necessary examination in several levels and shafts, and am perfectly convinced it does not require over 50 holes to cut a cubic fathom if the holes are placed in a miner-like manner; neither can I get to 16 tons of solid rock to a fathom (I shall be very glad to learn how he makes his calculation). If such calculations by "Pedn-an-drea" are to be taken for facts, I should be very sorry indeed for such a miner to have charge of any property I may be interested in, for is it any wonder he should be one of those designated as an unqualified mine agent, as it is quite feasible to me in this case the "blind is leading the blind," and I shall, with your numerous readers, be glad to hear from him what practical experience he has had, when and where, and with what drill?

A word to your correspondent John Roberts, who will try to make your readers believe is filled to overflowing with learning and wisdom of late. I well remember, a few years ago, a John Roberts, who now resides at Carnarvon, became a member of Breage Mining Class, and his knowledge of mining was so great and practical, although he was a working miner of many years' standing, that he failed to pass the most simple examination in mining, when farmers' and tradesmen's sons, who had never entered a mine, passed with great credit not only to themselves but to their teacher; yet, in the face of all this, he has turned up as an advocate for a thorough examination in mining, &c. All very good, but where should we find him? Not where I should like to be found, and I firmly believe his knowledge of technical education, if proved, will still be found to be of a low grade. He writes about studying chemistry, mineralogy, geology, and mathematics. Well, in no duty in life does the old Latin motto better hold than in this, "Perseverance overcomes all difficulties," as, if my memory serves me correctly, he did, with encouragement to persevere, obtain a 3s. book for making himself acquainted with the first principles of chemistry, which does not require much study with one who is possessed of an ordinary

amount of brains; and if he has made himself acquainted with mineralogy and geology, it is of a very recent date, which I doubt very much; and he being so well up in mathematics, probably we shall soon be furnished with a new work by John Roberts. But, for the future, I think it will be better for him, and the company he now holds the position as mine agent under, that he pays greater attention to his own affairs and not be meddling with things which does not concern him, and that it is folly for him to be wise when self-sufficient ignorance is his bliss. ARQUERITE.

BIRMINGHAM (BLAKELEY HALL) COAL AND IRONSTONE COMPANY.

SIR.—Our attention has been called to a statement in the Journal of Feb. 27, that the overdue interest on the debentures of the Birmingham (Blakeley Hall) Coal and Ironstone Company (Limited) would be paid forthwith, on presentation of the coupons. We are doing all we can on behalf of the trustees to secure this desirable result, but the statement we have referred to is not correct, and as it is calculated to mislead the debenture-holders and preference share-holders, whose interests we represent, we should be glad if you would either contradict it in your next issue or insert this letter. Birmingham, March 19. WHATELEY, MILWARD, AND CO., Solicitors for the debenture holders' trustees.

WELSH GOLD MINING.

SIR.—The different reports made from time to time upon this subject have created no little ambition in the minds of many, and often have they desired, like the Barons of old, "to see whether these things be so or not," especially since the discovery of the Vigna and Clogau Mines. Anyone who has paid a visit to this part of North Wales will not maintain a doubt but that the hills in the parishes of Llanabar, Llanddwywe, and Llanelltyd abound in the precious metal. Some say that gold was found in this locality about the year 1846, but it was found in such abundance that "Wild Wales" might well be termed "Golden Wales." Nevertheless, different reports were spread abroad concerning gold mining in Wales by those who believed that "no good could come out of Nazareth." These gave but little encouragement to the gold enterpriser in Wales, for they so hardened his heart that it would not allow his pocket to render to Nature the necessary help to bring forth her treasures; but by this time, with the help of labour and science, the hills of Merioneth speak for themselves.

In order to satisfy my curiosity, I obtained permission from one of the proprietors to go and see the Vigna and Clogau Mines. These works are situated upon the hills from which they take their name, about half-way between Dolgelly and Barmouth, in the midst of the most picturesque scenery. The mill is built on the bank of the River Cynogau, the water from which is taken with the greatest ease for the use of the mill, &c. There are four Britten pans there fixed up at present, but we understand that the work is now only in its infancy. Since the present proprietors have taken it in hand everything has been going on at a very progressive pace. It so happened that the day we were there (March 23) was the "cleaning-up" day; we, therefore, saw 65 ozs. of amalgam weighed and put into the retort, which, after going through the usual hot process, produced 14 1/2 ozs. of gold; we understand that this quantity of amalgam was the work of the pans for a fortnight. On the same range is also the Cefn Coch Gold Mine situated, where most beautiful machinery is put up, and 20 head of stamps working in full way, with very satisfactory results, under the management of a Mr. Reilly, an experienced man in gold mining from California. Within three miles to Cefn Coch lays the Gwynfynydd Gold Mine; this is situated on the banks of the Rivers Cain and Mawddach, close to the noted waterfalls on those streams. This mine is now unfortunately at a standstill, but we found from the man in charge of the property that the work will soon resume operations, and I should say from the specimen of quartz we saw with very satisfactory profit. VERITAS.

SUCCESSFUL AND UNSUCCESSFUL MINING.

SIR.—The heading of this letter, which appears of late to have been used by Mr. T. H. Allen and others as a caption merely, embraces a very wide area, and one might have expected to find from published letters on such a subject a decided reference to the conduct of mining, showing the errors committed by those entrusted with its management, and setting forth in an intelligible form a mode of correcting them, so as to avoid the evil consequences incident to the present practice; but, instead of that, we have been accosted with fulminations consisting of a diatribe of invectives as untruthful and senseless as they were malicious in conception and futile in effect.

The writers of those malicious squibs seemed to have overlooked the fact that mine agents are not a self-constituted body, nor are they, unless in exceptional instances, appointed by relatives, and even then there is no reason why the relatives and friends of influential persons should not be as well qualified as ambitious non-descripts. Those gentlemen in whom is invested the power of selecting and appointing mine agents must have betrayed a singular inaptitude for the business entrusted to them to have picked out the most inferior and inexperienced workmen to make captains of. How much it is to be regretted that Mr. T. H. Allen had not sounded his trumpet earlier. He blows lustily, and somewhat persistently, but he does not seem to be favoured with an ear for music after all, although he, no doubt, fancies that the sound of his horn, which as yet has uttered but one note, is dulcissimus and charming. He appears, however, to have somewhat improved in mental comprehension and range of vision, although he repeats his one note, that "Germans and Americans are superior in practical administrative capacity to the Cornish," with as much self-confidence and complacency as if it expressed all the notes in the gamut of mining. His recent acquisition is, as he tells us, "an idea"—that Cornishmen have the ability to work when directed by men of fertile brains. I do not know whether most to admire this compliment or Mr. T. H. Allen's recent discovery of "an idea." Who knows but that he may yet have room for one or two ideas more when his capacity shall have been enlarged by experience, and he be enabled to realise the astounding fact that the world contains more of everything than he is at present wont to persuade himself that it does. Mr. T. H. Allen's opinion of Cornish mine agents, taken in connection with Mr. John Roberts's very flattering encomium in last week's Journal, makes one feel uncommonly proud of being one of the number referred to. If those gentlemen have not taken leave of their senses, their senses must have taken leave of them; and the difference of such an alternative is one which can only affect themselves, as in the former case if they have taken leave of their senses, they may know where again to find them, whilst in the latter if their senses—supposing them to have had any—have taken leave of them, their re-possession is not quite so easy a matter.

Mr. T. H. Allen has shown by his letters that he is nobody, and Mr. J. Roberts that he is not a miner. Miners can no more be manufactured by book learning than generals for the army or admirals for the navy can be, and if he were a practised miner he would know that such is the case. He has, however, published his qualifications, which consist, if we may hazard an inference, of chemistry, mineralogy, geology, mathematics, &c., whatever the &c. may include. If these are his best credentials I have no hesitation in telling him that he is as far from being a miner as he was before he commenced to acquire them. They are useful branches of knowledge, but when possessed in a much more eminent degree than I think Mr. John Roberts can boast of, they may leave their possessor as unqualified for mining as one who is without them. Mine adventurers do not want amateur experimenters on science or any branch thereof which cannot profitably be applied to mining.

Will Mr. J. Roberts be good enough to inform us of what use a knowledge of the composition of minerals, chemical or otherwise, can be in the practical development of a mine? Could it add anything to the miner's skill in the prosecution of his exploratory operations? Would the knowledge that a particular crystal was isomorphous, diamorphous, or pseudomorphous enable him to discover and extract the metalliferous minerals at a more expeditious and profitable rate, and render them marketable, better qualified in

value, and add thereby to the product of capital by an increased revenue of interest, according to the amount invested? I think the testimony borne by himself in his letter relating the conversation between himself and his friend regarding his own pursuits and employment a philosophy which he seems never to have thought about. *Cui bono* is the language of plain practical commonsense. Why labour for the acquisition of that which can bring you no profit, nor any benefit to others? Much less torture the mind by persistently poring out of it that for which it has no capacity, and which if by due application, and no field for its useful and beneficial exercise existed. *Cui bono, cui bono*, the complimentary question "What a fool you are," must be esteemed at its proper weight.

A CORNISH QUADRUPLE.

SUCCESSFUL AND UNSUCCESSFUL MINING.

SIR.—In remarking on this subject in the Supplement to the Mining Journal of March 13, I had no intention whatever of giving anyone to understand that Cornishmen alone were one-legged miners. I intended the term to apply to certain classes of men in every country in the world where mining is carried on, and in included. I believe a Cornish mine agent is just as good and as far behind us for practical mining knowledge more especially. I intend that in order to carry on mining operations to a successful end theory and practice must go hand-in-hand, and that either one or the other standing alone is quite insufficient to qualify a man as a competent mine manager. I have no doubt whatever that Mr. Knapp is a real fine man if you put a dowsing-rod into his hand, and which is I dare say the invincible leg he speaks of, but allow me to inform him, whatever florid language he may see fit to employ in the vain endeavour to prop up his brother one-legged miners, the days are to a great degree gone past when a discerning public can be bamboozled by such flouting, though flimsy, arguments. How beautifully he burnishes up that counterfeit conjecture, in order to pass it off as genuine and sound theory, but guesswork has cost the mining world too much to be palmed off as theory any longer. There must, of necessity, be sound and solid rules to work from, founded on real, genuine, theoretical, and practical knowledge, otherwise mining is, to say the least of it, simply a delusion and a snare. As a purely practical man is but partially educated in mining, so also a theoretical man is but partially educated, but when a mining establishment is large and strong enough to maintain both these functionaries, and that they work in harmony and for the common benefit of the adventurers, then there can be no reasonable fault found, but when the management of a mine is wholly entrusted to either one or the other failure as a natural consequence is bound to ensue. The man of men is the sound, theoretical, and practical miner; he is capable of performing the united work of the two above-named individuals, and as a manager of mines is most valuable, being beyond question competent to undertake the full supervision of the most complicated mining. Barrow-in-Furness, Lancashire, March 24. UN INGLESE.

RICHMOND CONSOLIDATED MINING COMPANY.

The heading given to the letter of Mr. J. D. Emersley in last week's Mining Journal having suggested that there were some defects in the company's titles, which appears not to be the case, we very willingly publish the subjoined letter from the secretary, and regret that either the heading or the communication should have caused any apprehension to shareholders, as they must be well aware that it was simply an *ex parte* statement from a claimant to a certain location, which we understand is pronounced of no moment by the able authorities consulted by the company:—

TO THE EDITOR OF THE MINING JOURNAL.

SIR.—The directors of this company have had their attention called to the insertion in the Mining Journal of last Saturday of a letter purporting to be written to the Editor of the Mining Journal by a Mr. J. D. Emersley, and they observe with extreme surprise and serious regret that you have, apart from the manifest impropriety of circulating such an *ex parte* statement, done so with letters introduced by way of heading printed in large type, defamatory of the title of the company to their mining property thus, "The Richmond Mine, and its Defective Title." You must, upon a moment's reflection, perceive the serious responsibility you have thus incurred, and as there is no foundation whatever for the statement that the company's title is defective, but, on the contrary, such an allegation is wholly untrue and libellous, the directors require a full and immediate retraction of it, and that the same publicity be given to the denial as has been to the slander complained of, which you must be aware has occasioned considerable damage to the company. By order of the Board, THOMAS W. HALL, Sec.

Coleman-street, March 24.

JAVALI MINE.

SIR.—The directors of this company having fixed their annual meeting for the 31st of this month, a few words on the position of the company may be acceptable to the shareholders. The sudden death of Mr. Hall, the late chairman, was a great calamity to the company, seeing that his untiring energy was engrossed in bringing the mine to a successful issue, and, by his wealth, providing funds for the working of the mine, and taking bonds for the amounts advanced by him to near upon 10,000l. In addition, I believe he had nearly 1000 shares in the capital of the company. Having been intimately acquainted with him for more than 25 years, I well know the high opinion he held of the value of the mine, and upon his advice, a friend and myself purchased 400 shares in the company, and hold them at the present time; and I feel sure that, had he been alive now, his holding in the shares of the company would have been very largely increased.

I mention these facts to my brother shareholders to let them know the opinion he held of the value of our property, and at the same time to show the reason why I became a shareholder in the company. It was with pleasure I read a week or two since in your valuable Journal the following announcement:—

"An effort is being made to strengthen the directory of this company which, if it succeeds, will have a beneficial effect on the price of the shares. The mine is looking well, and all that appears requisite to ensure greater success is more energetic management."

I fully concur in this being done, and I believe most strongly that if our manager, Capt. Sohns, could be provided with 20 or 30 additional stamps, in addition to those he has now in use at the mine, returns much in advance of the last satisfactory monthly one—855 ozs. of gold, yielding 3 oz. average per ton, with a profit of 1598l. for the month, would be easily obtained.

In conclusion, I trust that the shareholders will, at the meeting on the 31st inst., carry out this policy of strengthening the board of directors, and give that assistance to our manager, Capt. Sohns, to carry out his high opinion of the value of the mine, testified by his buying, when last in London, several hundred shares in the company, and expressed in his own words—"that the mine was in value equal to the St. John del Rey." A. B., HOLDING 400 SHARES.

NEWFOUNDLAND MINING COMPANY.

SIR.—We appeal to you, as the organ of the mining interest, to assist us in obtaining an independent and open settlement, or adjustment, or winding-up, of the affairs of the Newfoundland Mining Company. Our client has invested 1000l. of hard cash in this unfortunate enterprise, and he also holds proxies, and has promised support from almost all the shareholders whose money has been expended by the directors, their servants, and agents, and whose policy is objected to only, we believe, by the holders of promotion shares, of which, as we contend, no value has been given.

As we forward you copy of a correspondence which has taken place between ourselves and Sir A. Malet, and the solicitors of the company, which correspondence has been printed and sent to every shareholder, we refer you to the views embodied in our letters on the matter, and shall be glad to have an expression of opinion upon the immediate issue we have raised.

Part of the proposal submitted by the directors on the last occasion was the appointment of one director as liquidator, but this was abandoned, in presence of the opinion of the shareholders assembled at the meeting; but it may be put forward again, and we contend that there will be no sufficient guarantee for an impartial investigation of the past conduct of the company, nor any security that wisdom and equity shall prevail in the liquidation and reconstruction.

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The CHAIRMAN: I have great sympathy with you, Sir, and moreover I have great admiration for you. (Cheers.) The Chairman then went on to say that this was the only arrangement they could make with Mr. Davis. It was one of the stipulations of the contract, he being one of the defendants in the Chancery suit, that

The lode in the east end (which is approaching the cross-course already alluded to in the upper driftage) is very large, beyond the size of the entire driftage, producing very strong magnetic impregnation with copper, altogether of a very flattering appearance, and of the same description as per sample sent this post. The lode in the west driftage going towards the great cross-course, and beneath the large porous lode first discovered in the shallow levels, is also of a kindly description, and yielding fine stones of ore, showing every indication of being increasingly productive as increased depth is attained. We may also remark that a very considerable amount of work has been accomplished in driving the adit levels into the hill, at comparatively shallow depths, as also cross-cuts extended both north and south, proving the existence of six tin and copper lodes in the present workings, all of which are intersected at various points by four separate cross-courses influencing the different lodes to the production of minerals—copper, tin, and arsenic—at the shallow levels, in places to the amount of 6, 8, 10, and 12 tons to the fathom. For the present and future development of the mine we think it advisable that no time should be lost in resuming and working the necessary preparations to sink the engine-shaft to a deeper level, which is undoubtedly one of the most important points to lead on to ultimate success, and open out a large and lasting mine. At the same time continue the present driftages at the 67 with so many hands as circumstances and the nature of the work may require. Also restore and lay a new tramroad in the shallow adit level, for the purpose of economical transit in bringing the product of the lode (which is principally arsenic and tin) to surface at the most proper and convenient spot for dressing the ore and making it marketable, which we calculate can be done at a good profit.—G. ROWE, J. MITCHELL.

A call of 1s. per share was made.

The shareholders expressed themselves pleased at the future prospects of the company, as in consequence of the new mode of treating mundie, of which this mine has thousands of tons, there is but little doubt but what they will be well repaid for their investment.

A vote of thanks to the Chairman terminated the proceedings.

BEDFORD UNITED MINES.

At a general meeting of shareholders held at the mine, on Tuesday (Mr. GEORGE PROUT in the chair), the accounts for the four months ending Jan. 30 were produced, showing the expenditure to have been 1120*l.* 2s. 3d., and the receipts for copper ores 680*l.* 5s. 6d., mundie 50*l.*, and calls 71*l.* 0s. 6d., leaving a cash balance in hand of 69*l.* 18s. 9d. A statement of liabilities and assets was produced, showing a balance against the mine of 777*l.* 4s., to meet which it was determined to make a call of 1s. per share.

The agent's report having been read and ordered to be received and adopted, a discussion ensued relative to the clause in the lease having reference to the development of the mine. The covenants of the lease having been read, much dissatisfaction was expressed at the arbitrary clauses exacted by the lessor, and the undue interference on the part of his mineral agents. As little hopes can be held out of any assistance being rendered on the part of the Duke of Bedford towards the opening up of the mine, it is clear that the shareholders must look out for themselves, and the following resolution was unanimously passed:—"That the manager be requested to comply with the terms of the lease as far as the employment of the men there stipulated is concerned, but that this mine at present is not in a position to spend money on unproductive ground." A few statistics were presented to the meeting by the secretary, by which it was shown that since January, 1865, when dividends ceased, 53,000*l.* had been expended for labour, material, management, &c., and of 4700*l.* paid to the Duke of Bedford for dues on ores, or equivalent to over 6 per cent. on the actual outlay, independent of water rent, rent of cottages, and a heavy charge for land damage, calls had been made on the shareholders of 14,800*l.*

A suggestion was made that the London office and local management should be blended into one; but no resolution was proposed, perhaps owing to the fact of it having been stated that half the mine was held in and about London, and that that interest, or about, was represented at the meeting, and further that the principal local shareholders were averse to any alteration of existing arrangements.

A vote of thanks to the Chairman concluded the proceedings of the meeting.

'For remainder of Meetings see to-day's Journal.'

COAL CUTTING MACHINERY IN AMERICA—THE MONITOR COAL-CUTTER.*

By JOHN S. ALEXANDER, Philadelphia.

The spirit of this age encourages the substitution of mechanical for hand labour wherever possible, experience proving that the employer, employee, and consumer share alike in the resulting benefits. Through the efforts of the inventor millions of the labouring class have been raised from being mere contributors of muscular force to be brain workers and directors of those ingenious contrivances now so widely used in the various branches of agriculture, manufacturing, printing, &c., by whose agency, with so much comfort to themselves, they not only earn the additional wages employers are enabled to pay, but also contribute to the world's progress in the ratio of the increased fertility of their operations.

While the Genius of Invention has accomplished so much in other departments, it seems remarkable that she has not long ere this descended into the coal mine with her wheels, levers, and eccentrics, and provided the toilers there with some device by which their unusually laborious work could be lessened. Until within a very few years, however, little special attention was given to this subject, owing largely, no doubt, to the fact that coal miners as a class were prejudiced against innovations of this kind, and ignorantly clung to muscle as the only means of wresting from Nature her treasures stored within the coal measures. Thanks, however, to the enterprise and skill of some Scotch and English mine proprietors and inventors, the present decade has seen rapid strides in the right direction, and mechanical coal mining has become a fixed fact in some portions of Great Britain. Making her acknowledgements to the Mother Country for these earnest and successful efforts, America now comes forward with the Monitor coal-cutter as the result of a trial on her part to advance the common cause of economical coal production; for upon cheap fuel the future greatness of both nations largely depends.

The object of this paper is to give a few items in regard to this Monitor coal-cutter; which, so far as the writer is informed, is the only coal-cutting machine in successful operation in the United States. It is the invention of Horace F. Brown, of Indianapolis, Indiana, and the result of a series of experiments extending over a period of nearly four years, during which time many different and some decidedly unique devices were tried before arriving at the present machine. It may be briefly described as a square cast-iron frame, revolving upon a lower frame or bed plate, and upon which the driving and feed parts are arranged with the greatest economy of space consistent with freedom of movement and accessibility, and a revolving cutter-rim, carrying the cutters and supported by a radial arm, attached to the frame. The power is supplied by two 8" by 9" trunk engine, driven by steam or compressed air carried from the mouth of the pit in iron pipes, which terminate with a sufficient length of rubber hose to allow of free motion to the machine. The details can be better understood by an examination of the accompanying drawings, which were made by Mr. Brown, who also prepared a full written description of the machine, from which many points in the following explanation were called. Fig. 1 gives a perspective view of the machine in operation, and Fig. 2 a plan view of the same. Similar letters indicate corresponding parts. The frame already referred to is shown by E; upon this rest the trunk engines G, G, 9 in. in cylinder diameter and 8 in. in length of stroke. Through the medium of the main shaft and worm 1 motion is communicated to the driving shaft H, carrying the pinion H', by which the cutter-rim is evolved. The cutting-arm, as already mentioned, is in two parts, the supporting-arm and the cutter-rim, and is a leading feature of the machine. The supporting-arm A is a flat open malleable iron casting, bolted firmly to the bracket C by a flange-like projection, and, with the exception of this projection, is entirely enclosed with the cutter-rim. Thus supported and steadied, and kept in place by a series of horizontal disc-like rollers A', is the revolving cutter-rim B, 5 ft. in diameter and 1½ in. in thickness, and which receives motion from the driving shaft H, by a circle of slotted perforations near its outer edge being engaged by the pinion already referred to.

This device does away with a hub, and enables the cutter-rim to penetrate the coal over 7-8ths of its diameter, or a depth of 56 in., and the power being applied at the circumference or point of resistance, there can be no loss by leverage. Upon the periphery of this revolving rim are placed the cutter holders, B', shown full size and with details in Figs. 3 or 4. Each holder is armed with four cutting points, two acting when the rim revolves from left to right, and the others when it moves in the opposite direction. These points are merely 2-in. lengths of ½ by 3 chrome steel, forged to an edge, and are held in place by blocks grooved so as to give them the

proper set (see Fig. 4). These blocks, as shown in Fig. 3, are fastened into the holders by screws, so that the operator can easily replace the points by others when they become dull. Fig. 4 also shows the order in which the cutter points are placed upon the cutter-rim. It will be noticed that they are set at different angles, so that although the action is continuous, the duty of each is only one-sixth of the kerf, and also that those points set at the greatest angle widen the cut sufficiently to clear the cutter-arm from both the overhanging coal and the bench beneath. The bracket C carrying the cutter-arm is attached to the sleeves, D D, which are vertically adjustable, and held at any desired elevation on the columns or guides, D' D', by means of the hand-worked cogged-gearing shown in Fig. 2. This enables the operator to raise or lower the cutter-arm at will, and select within a range of 3 ft. 6 in. the most favourable part of the seam for the cut. Either of these sleeves can be adjusted independently of the other, and the cutter-arm thereby angled in such a manner that the machine can be worked in a seam dipping or rising rapidly, and also avoid any interlaminated rock or slate which may interrupt a straight cut. The driving shaft, H, being in sections, one of which is squared and telescopes into a correspondingly squared sleeve upon the other, is capable of longitudinal adjustment, which, in connection with the universal joint H', enables it to accommodate itself to the variable elevation of the cutter-arm. By the shaft J, and a system of intermediate gearing so compounded as to reduce the speed, the worm I is geared to the upright capstan J', around which the draft or feed chain passes; and to bring the draft as near as possible to the point of greatest resistance, this chain also passes over a roller under the bracket C, and is then carried along and made fast at the end of the wall, as seen in Fig. 2. This gives the machine an automatic feed to the right or to the left, or forward or back, according to the position of the fast end of the chain. The speed can be regulated to suit the hardness of the coal by reducing or enlarging the capstan. The feed gearing shown in the drawings will move the machine at the rate of 9 in. per minute, the main shaft making 180 and the cutter-rim 6 revolutions in the same time.

The machine runs upon an ordinary T-rail track of the same gauge as the mine system, so that the pit cars can follow and remove the coal. Each working face has its own track, which is moved up to the new face as soon as the coal loosened by the former cut is cleared away. When drawn over the mine-track system, the machine is provided with 15-in. flanged wheels, fitting upon spindles, F, F', F'', F'''; but upon reaching the place of operations they are laid aside, and the machine is trundled upon a series of small rollers, F, F', F'', F''', with pivoted bearings, which allow of their being turned at right angles, so as to run upon either the wall track or the hereinafter-described cross track. Similar rollers, F', F'', F''', placed horizontally and bearing against the inner sides of the rails, serve in lieu of flanges on the other rollers, for keeping them upon the mills.

Preparatory to making a cut, the track, K, K, is placed parallel to the wall, adjusted by set screws in the ties, and braced as far as possible against neighbouring props; a cross track, K', K', intersecting and extending from it at right angles, connects with the mine-track system. With the feed chain and cutter-arm extending towards the coal to be attacked, the machine moves forward against the face, and the cutter-arm channels its way into the coal until upwards of 7-8ths of its diameter has penetrated the mass. By this time the machine has reached the intersection of the two tracks; the segmental plates K'', K'', K'', which thus far have formed a part of the cross track, are now turned so as to bring their straight sides on a line with the main track; the rollers F, F', F'', F''' are also turned at right angles to their former position; the feed chain is carried along the track, and the machine being again put in motion moves along the wall to any desired distance, making a continuous 1½ in. cut to the depth of 56 in. By the cutter holders being pivoted the machine can be fed either to the right or to the left, the cutting points which are ahead being thrown up when the rim revolves. This feature, together with cutting its own starting place in the coal, gives the Monitor great advantage over many English machines designed for making a similar undercut. When the limit of the wall track is reached, the feed is thrown out of gear without stopping the cutter-rim, and by the hand-worked gearing, H', the entire machine, with the exception of the lower frame, E, which always remains parallel to the wall track, is slowly swung round, the cutters continuing their work until the cut is sufficiently squared up to allow of the coal being wedged or blasted down even with the rib or pillar without recourse to the pick. A cross track, similar in all respects to the one already described, now receives the machine, and the flanged wheels being replaced it is moved to the next face. In Fig. 2, the machine is represented as approaching the cross track. The curved rails, L, L, are laid down after the machine is removed for the accommodation of the pit cars, which when the latch switches, K'', K'', are open, can readily pass one track to the other.

The chipping in the form of fine slack are carried around with the cutters and deposited between the track and the wall, and the cut is kept so free that it has never been found necessary to resort to scrapers before taking down the coal. Machines built on this system have been in use since June, 1873, in Messrs. Niblock, Zimmerman, and Alexander's Coal Brook Mine No. 3, near Brazil, Indiana, working in both the upper and lower block coal veins of that district. This coal, especially that of the lower vein, is very hard and dense, and being of a stratified nature is so difficult to mine that wages rule higher in this field than in almost any other part of the United States. The work imposed upon the cutter in this mine has, therefore, been very severe, affording an opportunity of testing its capabilities very thoroughly.

One of the most frequent objections advanced against coal-cutting machinery—the rapid dulling of the cutting points has been very satisfactorily overcome in this machine by the use of chrome steel, and in the hardest coal yet met with 6 yards have been cut with one set of points, while in a softer part of the vein which partakes of that cuboid structure characteristic of the ordinary bituminous or coking coal, 25 yards have been reached. The increased durability of the cutting points, as well as the relief the machine experiences when the cut is made in this comparatively soft coal, render it safe to assume that in a coking coal seam the average results would be much greater than those which have accompanied the machine's highly satisfactory operations in its present field. The item of wear and tear has been reduced to a very satisfactory point, and as most of the parts move slowly, and cast-steel and malleable iron are used wherever the friction and strain are greatest, little trouble is found from this source. The cutting points are forged from rods of chrome steel, and supplied by bolt and nut manufacturers, who, by using a die prepared for the purpose, can turn them out very rapidly. They are sharpened from time to time on an emery wheel, and if tempered with care will last a long while.

For many reasons compressed air is the only desirable motor for machinery in mines, and for some times has been used in Coal Brook mines, although in the outset steam was employed. The main conveying pipe is 3 in. in diameter, which answers for conducting the compressed air the comparatively short distance of 500 ft. now required. It may, however, be found more advantageous in future and more extended operations to use a still larger pipe, thereby reducing the loss by friction.

Some of the advantages claimed for this coal-cutter over hand mining may be briefly summed up as follows:—In the first place, the waste in the under-cutting process is reduced to such an extent that the saving is sufficient to pay the operating expenses of the machine. Experience in block coal mining proves that one-sixth of the product is slack or waste, or taking 100 tons as the basis of our calculation, 16 tons would represent this waste. The 1½ in. cut made by the machine is 1-32nd of a 4-ft. vein, the standard thickness in the block coal region, and 1-32nd of the 100 tons equals (say) 3 tons, which amount being deducted from the 16 tons shows 13 tons of merchantable coal in lieu of the 16 tons of slack. The slack sells for \$5 per car of 12 tons, or \$6.66 for the 16 tons, while on the other hand the 13 tons of merchantable coal have a value of \$22.25 per ton, or \$29.33, a clear difference of \$22.67 in favour of the machine from this one item alone. To operate the machine an engineer and two track-layers are required, at \$3 for the former and \$2.50 each for the latter, per diem, making \$8 for each shift

producing 50 tons, or \$16 for the two shifts producing the 100 tons, which, deducted from the \$22.67, still leaves \$6.67 for oil, repairs, and expenses of the air-compressor, which is run by the engine driving the hoisting-engine.

The reduction of waste, therefore, in paying the cost of the under-cutting, leaves the taking down and loading of the coal as the only expense to be compared with the price of hand mining. This being 50 cents per ton against \$1, as the average of hand mining puts the cost of "getting" one-half, and the dead work remaining the same as now, 50 cents per ton, the expense of putting coal on the cars at the mouth of the mine would not exceed two-thirds of the present cost. One man following the machine can take down and load 10 tons in a shift of 10 hours, so that very satisfactory wages could be earned at 40 or even 30 cents per ton for that work, which would still further widen the difference shown by the above calculation. Two other important advantages are worthy of mention in this connection, to wit: The lessors of coal territory under leases waiving all royalty on slack and nut coal, receive revenues augmented in the ratio of the increase in the proportion of screened coal; and the dealers and consumers, as already experienced by a large consignee of the product of Indiana mines, find machine-cut coal so free from slack and dirt that it is much more saleable and in all respects preferable to that mined by the pick. How will the introduction of coal cutters be received by the miners? is naturally a very important question. In reply, it may safely be said that the shrewdest and most intelligent miners will gladly welcome the day and the means bringing relief from the arduous task of undercutting, and will most willingly exchange it for the lighter work of taking down and loading the coal. No doubt the ignorant and prejudiced will at first regard the innovation unfavourably, but when it is shown that with the lightening of their toil will come no corresponding reduction in their periodical earnings, nor diminution of employment, they too will doubtless cheerfully accept the situation.

It should be borne in mind that the vast annual increase in the consumption of coal, and the constant widening of the area of production, do now and will continue to tax the supply of skilled miners.

So great has become the demand for labour of this class, and so largely remunerative the wages offered, that in all mining regions are to be found large numbers of clumsy makeshift miners gathered from all sources, who are so unfitted for the work they attempt that they not only cause an unnecessarily large waste, but are very frequently to blame for the accidents which occur in mining operations.

In the event of the immediate general introduction of coal-cutting machinery, the services of all the best and most skillful miners would be required; for men acquainted with underground work are decidedly preferable to all others for following a machine; and although coal would be produced at two-thirds the present cost, the quickening of the demand to be brought about by lower prices, and the assurance of a regular and uninterrupted supply, would ensure full employment to miners of this class. But it is not within the remotest bounds of possibility that this change from hand to mechanical mining will be immediately brought about. It will take place gradually, probably with no greater rapidity than the increased consumption of coal. Therefore miners, skilled or unskilled, should at once abandon the idea, if they now entertain it, that the introduction of coal-cutting machinery, into American mines especially, will to any degree lessen the demand for their services. Experience in other departments of labour abundantly proves the fallacy of such a theory. The same argument was advanced against the steam-engine, the sewing machine, and the reaper and mower; and when railways were first projected many prophesied that the iron horse would soon render our pacers and trotters comparatively worthless.

The introduction of mechanical mining, by simplifying and systematising the work will render less frequent those misunderstandings between operators and men which too often lead to disastrous strikes. An era anxiously looked for, not only by manufacturers and mine owners, but also by those who have in view the true interests of the miners themselves.

The diagram will show what has been adopted at the Coal Brook Mines as the most approved plan of opening territory for machine operations. The lateral entry is driven 138 yards, and, separated by a 6-yard rib, an air-way is carried parallel to it the same distance. Leaving a 6-yard rib to support the main entry, the wall of the air-way is divided by 6-yard ribs into three 40-yard faces. The machine cuts the most distant face, and is then moved to the second, and repeats the operation while the coal in the first face is taken down. By having a third face always in reserve, the machine need not be delayed in case of a failure on the part of the takers down to have the coal cleared from the first face cut. In the long rib openings are made at intervals through which the loaded cars can be pushed to the entry. Doors being provided for closing these openings when not in use, the air current to the limit of the working is not interfered with. When the faces are worked back 30 yards the ribs are drawn, and operations transferred to another place. In a 4-ft. seam the capacity of a one machine mine opened in this manner would be 50 tons each shift of 10 hours, or by running night and day the output would reach 100 tons in 24 hours. The production of the same quantity by manual labour alone would require the enlargement of the working area so as to accommodate 30 to 40 men, together with an accompanying increase of mine equipment. Machine cut coal comes out so free from slack that high buildings for dumping and screening are unnecessary, and at drift mines an engine might be entirely dispensed with.

Another very important feature recommending machinery is that, operations being more concentrated, less territory is required to be opened, and the coal is so rapidly removed from the part of the mine worked that much of the annoyance and danger from disintegrated roofing and pillars is escaped.

It should also be mentioned that the machine above described can be used very successfully in driving entries and in turning rooms. In entry work the machine is advanced to the face of the heading, and moving forward upon a straight track laid along the entry channels its way in, after the manner already described, and when the limit is reached it is swung to the right and to the left, undercutting to the width of 14 ft. if desired.

NOTE.—Since the above paper was read before the Institute, some modifications in the description of the machine have been made in order that it may embody some recent improvements, by which improvements the capacity of the machine is brought up to 80 tons for each 10-hour shift, and the durability of the cutter points so increased that one set will cut a 40-yard face.

J. S. A.

[The diagrams referred to in this article are shown on the opposite page.]

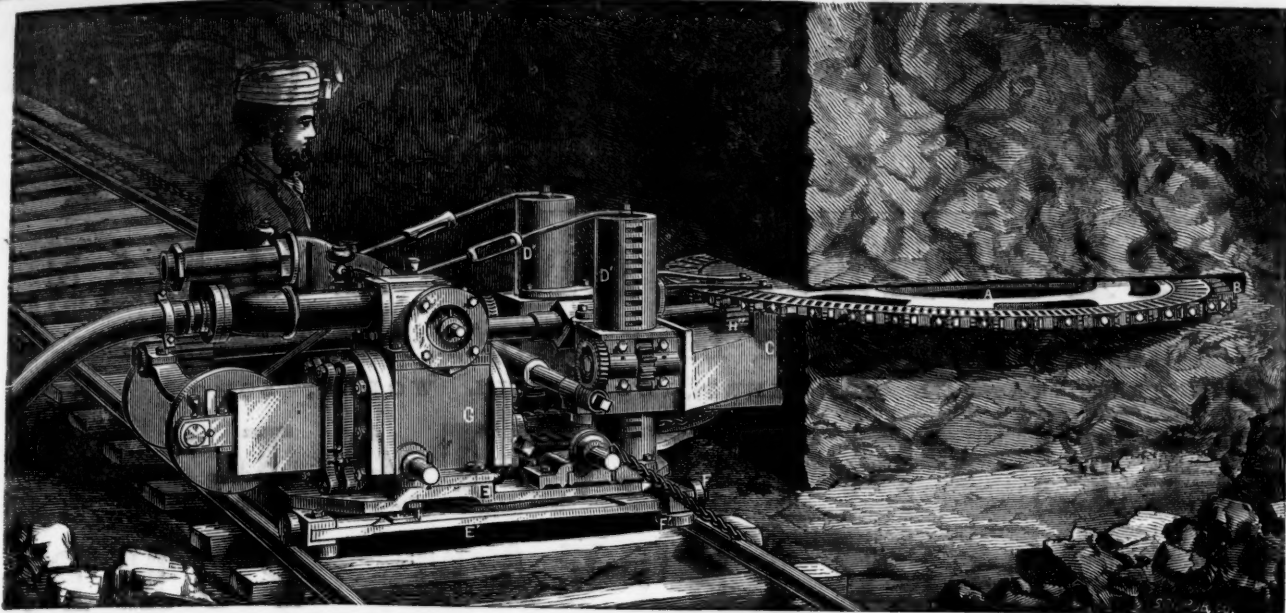
SUPPLYING FUEL TO FURNACES.—The improvements invented by Mr. THOMAS HENDERSON, of Liverpool, consist in constructing the bottom plate of the fan-boxes in two parts or sections. In driving the fans by extending the pinions into the concave or hollow part of said fans. In placing the driving shaft of the apparatus immediately above the fan-boxes. In the employment of a swing-plate or plates forming either the front or back, or both the front and back of the crusher-box for crushing and feeding the coals. In driving an upright crusher by means of a shaft extending through the fan-boxes, which shaft gear into a horizontal driving shaft placed below the fan-boxes. In providing the interior of the crusher-box and exterior of the crusher with horizontal cutting blades, which are so formed and arranged that the blades or cutters on the exterior of the crusher work between the blades or cutters in the interior of crusher-box.

LAW CASE IN CHANCERY.—The bill in Chancery filed by the proprietors of the Barleigh Rock Drill Machine, for the purpose of restraining the sale and use of the Cranston Rock Drill Machine (invented and patented by Mr. J. G. Cranston, of Newcastle-on-Tyne), has been dismissed with costs.—*Newcastle Daily Journal.*

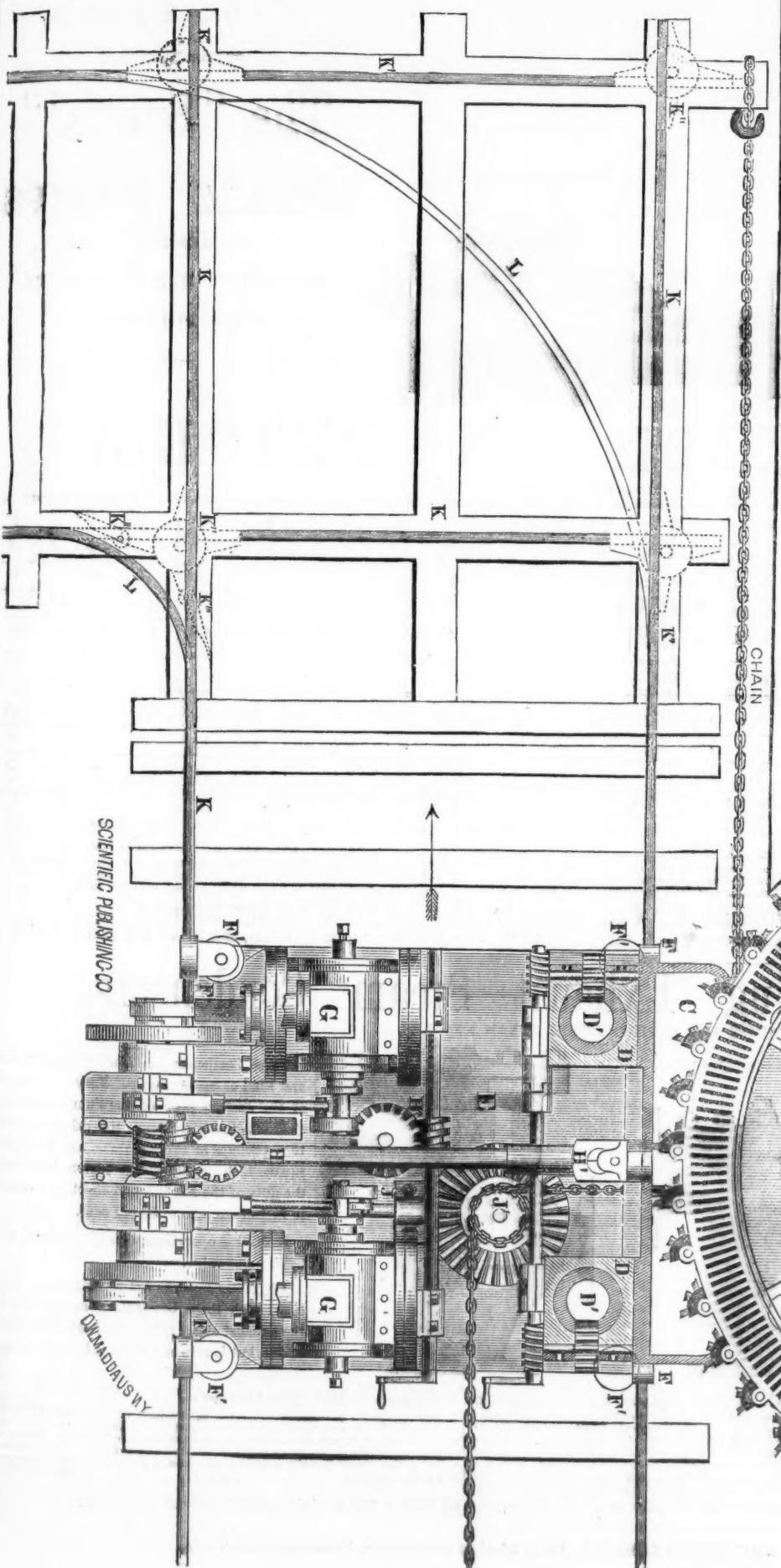
RAISING THE DUNHAILE CASTLE.—This vessel having caught fire in the West India Docks last week, was scuttled. The task of raising her again was successfully accomplished on Tuesday, by the simple process of slinging over her forecastle two of Hayward Tyler's self-contained steam-pumps, which were in any position without fixing, and require only to be supplied with steam by a flexible pipe from the boiler of a steamboat moored alongside. After some hours of steady pumping, at the estimated rate of 200 tons of water per hour, the leaks were over come, and the vessel floated. She is towed into Fletcher's Dock, at Limehouse, for repairs.—*Times.*

EPPE'S COCOA—GRATEFUL AND COMFORTING.—"By a thorough knowledge of the natural laws which govern the operations of digestion and nutrition, and by a careful application of the fine properties of well-selected cocoa, Mr. Eppe has provided our breakfast tables with a delicately flavoured beverage which may save us many heavy doctors' bills. It is by the judicious use of such articles of diet that a constitution may be gradually built up until strong enough to resist every tendency to disease. Hundreds of subtle maladies are floating around us ready to attack wherever there is a weak point. We may escape many a fatal shaft by keeping ourselves well fortified with pure blood and a properly nourished frame."—*Civil Service Gazette.*

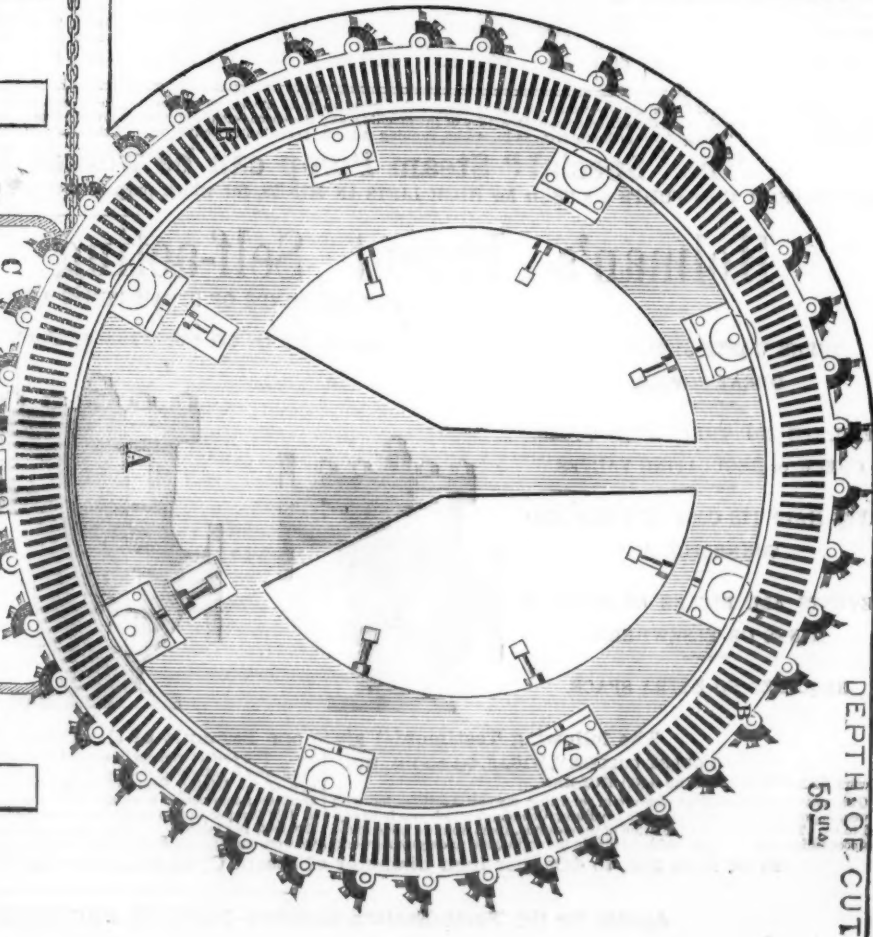
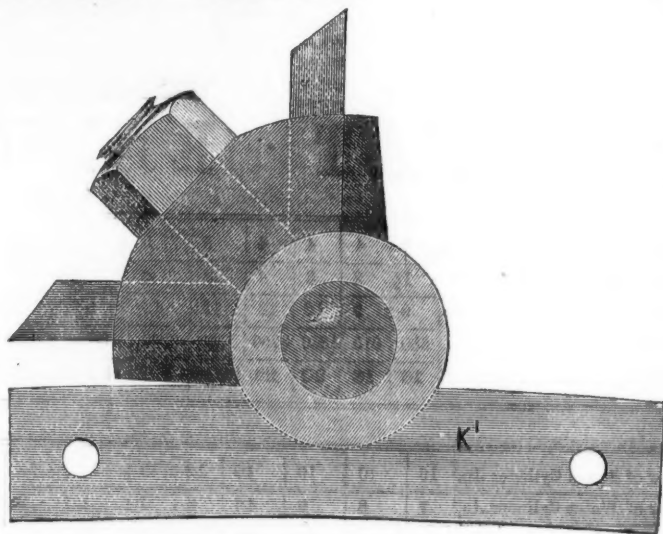
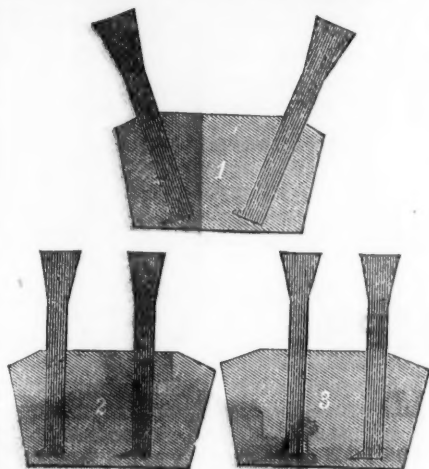
* A paper read before the American Institute of Mining Engineers at the St. Louis meeting, as for a copy of which, with engravings of the illustrations accompanying it, we are indebted to the *Engineering and Mining Journal*, New York, one of the best authorities upon the subjects of which it treats in the United States.



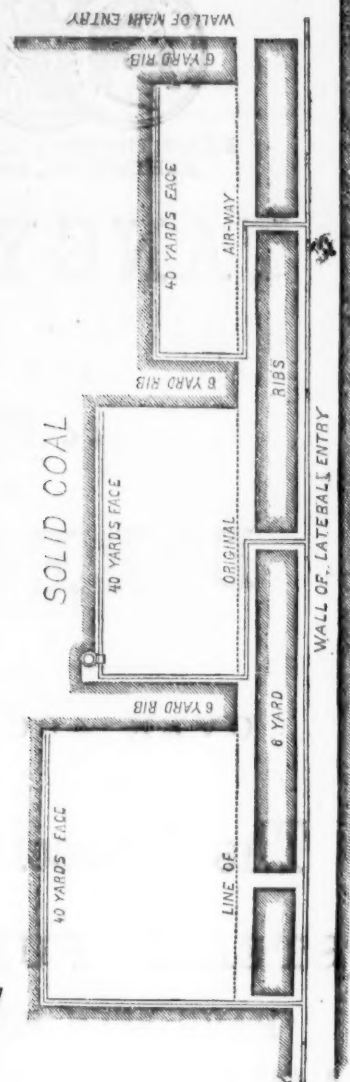
RIB



FACE OF COAL



DEPTH OF CUT
56 in.



SOLID COAL

WALL OF MAIN ENTRY

6 YARD RIB

30 YARD RIB

AIR-WAY

6 YARD RIB

ORIGINAL

40 YARDS FACE

6 YARD RIB

6 YARD

LINE OF

WALL OF LATERAL ENTRY

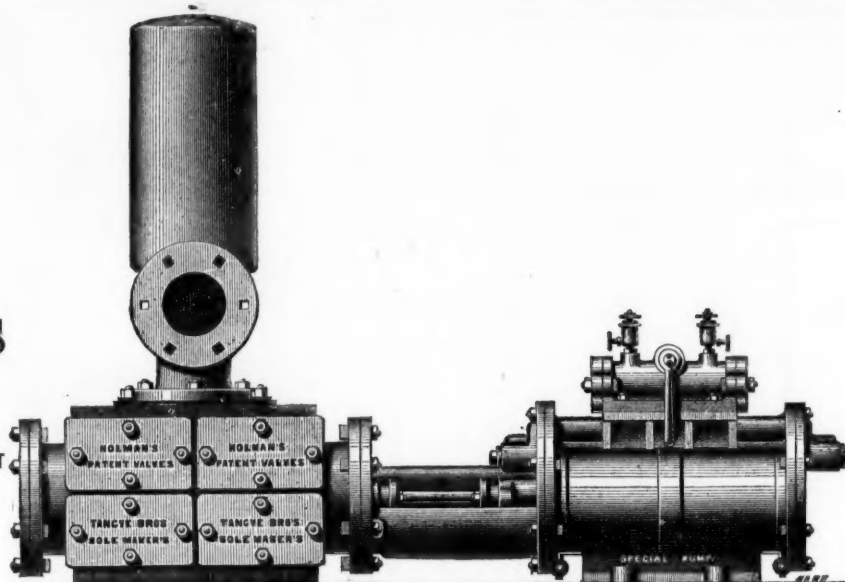
PARIS INTERNATIONAL
EXHIBITION, 1867.VIENNA INTERNATIONAL
EXHIBITION, 1873.LONDON INTERNATIONAL
EXHIBITION, 1874.CORNWALL POLYTECHNIC
SOCIETY, 1867 and 1873.

TANGYE BROTHERS AND HOLMAN,

10, LAURENCE POUNTNEY LANE, LONDON, E.C.,
AND BIRMINGHAM, (TANGYE BROTHERS), CORNWALL WORKS, SOHO,

“THE SPECIAL” DIRECT-ACTING STEAM PUMP.

OVER 4000
OF
The “Special”
STEAM PUMPS
HAVE BEEN SOLD
SINCE THEIR INTRODUCTION
IN 1867.



200 SIZES
And combinations of
The “Special”
STEAM PUMPS
ARE NOW
MADE FOR EVERY VARIETY
OF PURPOSE.

GREAT REDUCTION IN PRICES.

The following sizes are suitable for low and medium lifts:—

Diameter of Steam Cylinder ...In.	3	4	4	4	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10
Diameter of Water Cylinder ...In.	1½	2	3	4	3	4	5	3	4	5	6	3	4	5	6	4	5	6	7	8	5	6	7	8	9
Length of Stroke .....In.	9	9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	18	12	12	12	18	24
Gallons per hour	680	815	1830	3250	1830	3250	5070	1830	3250	5070	7330	1830	3250	5070	7330	9750	3250	5070	7330	9750	13,000	5070	7330	9750	13,000
Price	16	18	20	25	22	10	27	10	32	10	25	30	35	40	30	35	40	45	50	40	45	50	55	65	85

CONTINUED.

Diameter of Steam Cylinder..In.	10	10	10	10	12	12	12	12	12	12	14	14	14	14	14	14	16	16	16	16	16	18	18	18	18
Diameter of Water Cylinder..In.	7	8	9	10	6	7	8	9	10	12	7	8	9	10	12	14	8	9	10	12	14	9	10	12	14
Length of Stroke .....In.	12	18	24	24	18	18	18	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Gallons per hour	9750	13,000	16,519	20,000	7330	9750	13,000	16,519	20,000	30,000	9750	13,000	16,519	20,000	30,000	40,000	13,000	16,519	20,000	30,000	40,000	16,519	20,000	30,000	40,000
Price	55	75	90	100	75	80	85	110	120	140	110	120	130	140	160	180	140	150	160	180	200	190	200	220	240

Intending purchasers of Steam Pumps would do well to observe the great length of stroke, short steam cylinder, and short piston of the “Special” Steam Pump, as compared with the short stroke, long steam cylinder, and long piston of the Pumps of other makers, as the efficiency and durability of the machine, and the space occupied by same, greatly depend upon this. The advantage of long strokes will be obvious when purchasers are reminded that each set of suction and delivery valves of a “Special” Steam Pump with 24 in. stroke, running at 120 ft. per minute, would open and close only 30 times per minute, as against 120 times per minute in a Pump with only 6 in. stroke performing same duty.

The “Special” Steam Pump can be worked by Compressed Air as well as by Steam.

HUNDREDS of these PUMPS are USED for HIGH LIFTS IN MINES, for which purpose they are made with 21, 24, 26, 28, 30, and 32-inch Steam Cylinders, and 36, 48 and 72-inch Strokes.

Holman's Patent Self-acting Exhaust Steam Condensers,

FOR ALL KINDS OF STEAM PUMPS AND HIGH-PRESSURE STEAM ENGINES.

Turns waste steam into
GREAT POWER.

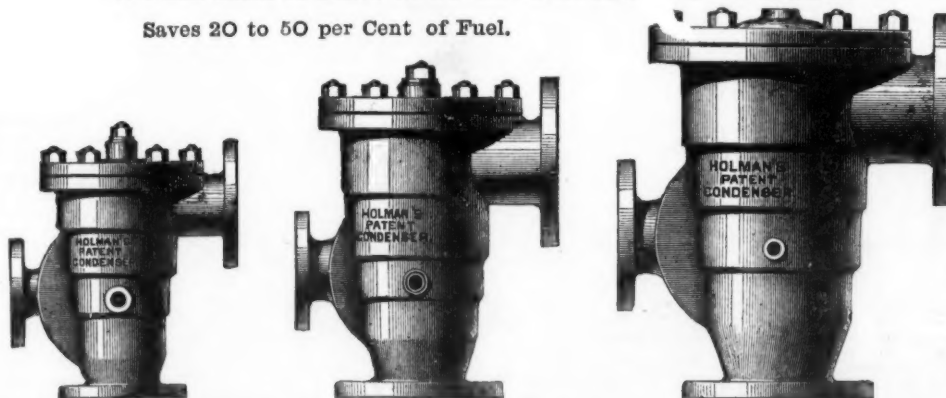
Saves 20 to 50 per Cent of Fuel.

REQUIRES NO THREE-WAY COCKS,
CHECK, or REGULATING VALVES.

SAVES HALF ITS COST IN PIPES AND
CONNECTIONS.

PREVENTS ALL ESCAPE OF STEAM IN
MINES OR ELSEWHERE.

REQUIRES NO EXTRA SPACE.



These Condensers are made to suit any size and kind of Steam Pump. They form a part of the suction pipe of the Pump, and while they effectually condense the exhaust steam, they produce an average vacuum of 10 lbs. per square inch on the steam piston, increasing the duty of the Engine, and effecting a saving in fuel of from 20 to 50 per cent.

In Mining operations these Condensers will be of great value.

All Boiler Feeders are recommended to be fitted with these Condensers, as not only is the exhaust steam utilised in heating the feed water, but is returned with it into the boiler.

The following Testimonial gives one Example of the Power Gained by the action of Holman's Patent Condensers:—

MORLEY COLLIERY, WIGAN, October 16th, 1874.

Messrs. TANGYE BROTHERS AND HOLMAN.

GENTLEMEN,—I have great pleasure in recording my entire satisfaction with the working of the Holman's Patent Steam Pump Condenser which you have supplied to us. The complete condensation of the steam is, apart from its value in the strict economic sense, a most valuable feature in the drainage of underground work.

Price from 30s. to 40s. per inch diameter of Steam Cylinder, according to the relative Diameter of Pump for which Condenser is required.

Agents for the North-Eastern District:—TANGYE BROTHERS & RAKE, St. Nicholas Buildings, Newcastle-on-Tyne.

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Every description of Leather, India-rubber, and Gutta-percha for Engineering and General Mechanical purposes.

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THE DRILLING MACHINES (IN FIVE SIZES) CAN BE MOUNTED ON ANY DESCRIPTION OF CARRIAGE OR SUPPORT, according to the nature of the work.

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CHEMICAL PLANT OF EVERY DESCRIPTION.

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AN INDISPENSABLE APPENDAGE TO STEAM BOILERS.



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In operation to
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VIENNA, 1873.

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of Fuel.



PARIS, 1867.

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Ore Crushers, with H.R.M.'s New Patent Crushing Jaw.

EXTENSIVELY USED BY
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Few Working Parts.
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Freedom from Breakage.
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Immense Saving of Labour.

Mining Improvements Revolving Picking Table

950 NOW IN USE.

AWARDED 45 GOLD AND SILVER MEDALS

By the PATENT MACHINE

HERE ILLUSTRATED

60 to 70 Tons of Ore

MAY BE

CRUSHED OR SEPARATE

PER DAY OF TEN HOURS.

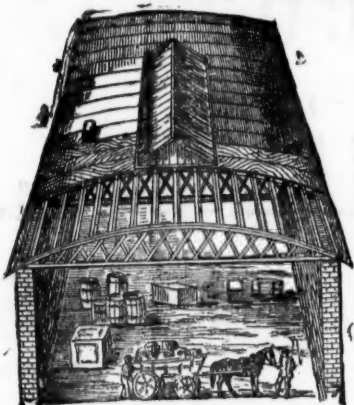
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"Although I have travelled hundreds of miles for the purpose of, and spent several days in, examining what are styled ORE CRUSHERS, your only embrace and combine the true principles of action and construction for the purpose designed."

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FOR
GREAT ECONOMY
AND
CLEAR WIDE SPACE.

For particulars, estimates,
and plans, address,—

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BELFAST.

The above drawing shows the construction of this cheap and handsome roof, now much used for covering factories, stores, sheds farm buildings, &c., the principal of which are double bow and string girders of best pine timber, sheathed with 1/2 in. boards, supported on the girders by purlins running longitudinally, the whole being covered with patent waterproof roofing felt. These roofs so combine lightness with strength that they can be constructed up to 100 ft. span without centre supports, thus not only affording a clear wide space, but effecting a great saving both in the cost of roof and uprights.

They can be made with or without top-lights, ventilators, &c. Felt roofs of any description executed in accordance with plans. Prices for plain roofs from 30s. to 60s. per square, according to span, size, and situation.

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Wholesale buyers and exporters allowed liberal discounts.

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By a special method of preparation, this leather is made solid, perfectly close in texture, and impervious to water; it has, therefore, all the qualifications essential for pump buckets, and is the most durable material of which they can be made. It may be had of all dealers in leather, and of—

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SOUTH WALES GAZETTE
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